Aroosa **Ijaz**

Quantum Physicist · Machine Learning Enthusiast · Inquisitive Scientist

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Education

University of Waterloo, Vector Institute
Toronto, Canada

PhD Physics CGPA: 3.9/4.0 *Sep 2020 - Dec 2025*

- **Thesis:** Quantum machine learning: theory, algorithms, and applications.
- **Supervisors:** Prof. Juan Felipe Carrasquilla, Prof. Roger Melko

ETH Zürich
Zürich, Switzerland

PhD Physics - **LEFT TO CHANGE TO COMPUTATIONAL PHYSICS*** *Nov 2016 - Oct 2018*

- **Thesis:** Towards realization of Majorana Fermions in 2D Transition Metal Dichalcogenide heterostructures.
- **Supervisors:** Prof. Klaus Ensslin, Prof. Thomas Ihn

Ulm University
Ulm, Germany

M.Sc. Physics (Quantum Information Specialization) CGPA: 4.0/4.0 *Sep 2014 - Aug 2016*

- **Thesis:** Low temperature spectroscopy of single color centers in diamond: Investigations into Germanium vacancy center in diamond.
- **Supervisors:** Prof. Fedor Jelezko, Prof. Alexander Kubanek

Lahore University of Management Sciences
Lahore, Pakistan

B.Sc. Physics & Computer Science CGPA: 3.27/4.00 *Sep 2009 - Aug 2013*

- **Thesis:** Experimental investigations on confined Excitons in quantum wells and quantum Dots embedded in optical microcavities.
- **Supervisors:** Prof. Ata Ul Haq

Work Experience

Los Alamos National Laboratory
Los Alamos, USA

Graduate Research Assistant *Sep 2023 - Present*

- Work on various research projects with the QML and QC group

Los Alamos National Laboratory
Los Alamos, USA

Quantum Computing Summer School Intern *June 2023 - Aug 2023*

- Worked on a research project on error mitigation applied to data-driven Quantum sensing

Xanadu.ai
Toronto, Canada

Quantum machine learning scientist *Sep 2019 - Aug 2020*

- Theoretical research on variational quantum kernels resulted in a seminal result and a patent (US Patent App. 17/118,004)
- Theoretical research on using Gaussian Boson sampling to assess graph isomorphism for drug development
- Contributed to developing and deploying the **mixed state simulator** in PennyLane to add the ability to simulate noisy quantum circuits
- Contributed to developing and deploying the **data module** in Strawberry Fields. It provides pre-generated datasets from GBS simulations for various chemistry, graph optimization, and machine learning problems
- Contributed to developing and deploying the **sample module** in Strawberry Fields. It provides functionality for generating GBS samples using classical simulators

Xanadu.ai
Toronto, Canada

Quantum machine learning research intern *May 2019 - Aug 2019*

- Improved community engagement with our software by adding educational documentation and tutorials to PennyLane website
- Development and deployment of additional features and gates to PennyLane qubit simulator

Quantum Photonics Group, ETH Zürich
Zürich, Switzerland

Research Secondment, Prof. Atac Imamoglu *Nov 2016 - May 2017*

- Conducted low-temperature electrical transport and optical measurements on monolayer MoSe2/graphene/HBN hetero-structures to explore exciton properties in dichalcogenides
- Hetero-structure acted as an electrically tunable atomically-thin mirror; publication in Physical Review Letters

Institute for Quantum Optics, Ulm University
Ulm, Germany

Research assistant, Prof. Fedor Jelezko *Jun 2015 - Aug 2016*

- Investigated quantum optical effects in the novel single Germanium-Vacancy centers in diamond
- Performed resonant extinction measurements on single Silicon-Vacancy centers in diamond as a high contrast detection technique
- Set up a confocal microscope to characterize synthetic diamond samples

Department of Physics, Lahore University of Management Sciences *Lahore, Pakistan*

Research assistant *Jul 2013 -Jun 2014*

- Computational modelling of different open cavity QED systems in MATLAB and solving their Lindblad equations (with Dr. Ata Ul Haq)
- Computational analysis of doping in Graphene by group IV elements executed in Siesta in Linux environment (with Dr. Fakhar Ul Inam)
- Simulating portable Hallbach NMR Spectrometer in ComSol modeling software (with Dr. Sabieh Anwar)
- Development of Quantum Erasure experiment based on Mach Zender Interferometer for Freshman Physics lab (with Dr. Sabieh Anwar)

Department of Computer Science, Lahore University of Management Sciences *Lahore, Pakistan*

Research Intern *Jun 2012 - Dec 2012*

- Proposing new fault-tolerant data center topologies with higher efficiency and resilience
- Statistical analysis of big data from a Google cluster of 10,000 servers. Designed data structures and a divide-and-conquer algorithm to efficiently process the data in Python.

Publications

2023	**Classically-hard Quantum Kernels** Aroosa Ijaz, Diego García-Martín, ... Marco Cerezo, https://arxiv.org/abs/ .	*In preparation*
2023	**Error Mitigation and data-driven Quantum Sensing** Aroosa Ijaz, Cinthia Huerta, ... Marco Cerezo, https://arxiv.org/abs/ .	*In preparation*
2023	**Signatures of double descent in deep quantum models** Aroosa Ijaz, Elies Gil Fuster, ... Juan Carrasquilla, https://arxiv.org/abs/ .	*In preparation*
2022	**Pennylane: Automatic differentiation of hybrid quantum-classical computations** Ville Bergholm, ..., Aroosa Ijaz, ... Nathan Killoran, https://arxiv.org/pdf/1811.04968.pdf.	*ArXiv*
2020	**Quantum embeddings for machine learning** Seth Lloyd, Maria Schuld, Aroosa Ijaz, ... Nathan Killoran, https://arxiv.org/abs/2001.03622.	*ArXiv*
2018	**Realization of an electrically tunable Narrow-Bandwidth atomically thin mirror using monolayer MoSe2** Patrick Back, Aroosa Ijaz, ... Atac Imamoglu, https://doi.org/10.1103/PhysRevLett.120.037401.	*Physical Review Letters*
2017	**Optical and microwave control of germanium-vacancy center spins in diamond** Petr Siyushev, Mathias Metsch, Aroosa Ijaz, ... FedorJelezko, https://doi.org/10.1103/PhysRevB.96.081201.	*Physical Review B*

Awards and Honors

2021-2024	**Vector Research Grant [CAD 6000 / Year]** , Vector Institute for Artificial Intelligence	*Toronto*
2021	**3rd position**, Xanadu.ai Quantum Hackathon	*Toronto*
2016-2018	**Marie Curie Young Researcher Fellowship [50, 000 Euros / Year]** , ETH Zürich	*Zürich*
2015	**Degree Scholarship [1500 Euros]**, Ulm University	*Ulm*
2014-2015	**Merit scholarship award (not availed) [PKR 219, 000]**, Lahore University of Management Sciences	*Lahore*

Community Engagement

National School on Quantum computing and Quantum machine learning *Lahore*

Organizer, Speaker *Apr 2024*

- Organizing a 7-day intensive school on QC and QML for undergraduate and graduate students in Pakistan
- 25 students from all over the country will be hosted at Lahore University of Management Sciences
- It will include panel discussions to see how Pakistan can stay a part of the global progress in Quantum technologies

International Women's Day Conference *Global*

Speaker *Mar 2022*

- Organized by Google's women techmakers and Pakistani Women
- I talked about advances in QML and tried to identify social factors that lead to the low number of women in Physics at all levels of education and employment.

Physics camp for girls *Pakistan*

Speaker *Dec 2021*

- 1200 high school girls from all over Pakistan participated. The camp was aimed at inspiring them about physics and STEM careers
- I gave a talk in urdu about quantum computing and its potential impact on technology and the society we live in.

Quantum Machine Learning meetup *Global*

Organizer *Apr 2021 - Apr 2022*

- Once every two months, along with two other enthusiasts, I virtually host a QML researcher and discuss their cutting-edge research

Quantum Computing Mentorship Program, Quantum Open Source Foundation *Global*

Mentor *Sep 2020 - Feb 2021*

- This program helps enthusiasts learn about quantum computing software development and research
- I mentored 3 participants in a research project on expressivity of variational quantum embeddings

Quantum Techniques in Machine Learning Conference *Global*

Program committee member *2020, 2021, 2022, 2023*

- Review papers submitted to this conference for quality publication

Canadian Conference for Undergraduate Women in Physics *Toronto*

Keynote Speaker *2020*

- This was a wonderful opportunity to inspire brilliant young women about Quantum Computing and Quantum Machine Learning! We also discussed challenges and biases women face in research

Teaching Experience

Department of Physics, ETH Zurich *Zürich, Switzerland*

Teaching Assistant *Nov 2016 - Dec 2017*

- Undergraduate Physics Lab: supervised two experiments with eight students every week
- Undergraduate Physics-1: conducted exercise classes, graded assignments and exams

Department of Physics, Ulm University *Ulm, Germany*

Student Tutor for struggling peer students *Jan 2016 - Mar 2016*

- Tutored 2 master students in Quantum Mechanics
- Tutored 1 master student in calculus and differential equations

Lahore University of Management Sciences *Lahore, Pakistan*

Teaching Assistant *Sep 2011 - Jun 2014*

- Data Structures, Quantum Mechanics-1, Mechanics, Atomic-Molecular-Laser Physics, Experimental Physics Lab-I

Skills

Programming Skills Python, MATLAB, Mathematica, C++, Octave, R
Machine Learning Qiskit, Qibo, TensorFlow Quantum, PennyLane, Scikit-learn, PyTorch, Cirq
Languages English[C2], Urdu[Native], Punjabi[Native], German[A1]

References

Prof. Juan Felipe Carrasquilla, Vector Institute, University of Waterloo *Toronto, Canada*

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Dr. Marco Cerezo, Los Alamos National Laboratory *Los Alamos, USA*

: +1 505 667 5061 : cerezo@lanl.gov : Google Scholar Page

Prof. Seth Lloyd, Massachusetts Institute of Technology *Massachusetts, USA*

: +1 617 252 1803 : slloyd@mit.edu : Google Scholar Page

Dr. Maria Schuld, Xanadu.ai, UKZN *Toronto, Canada*

: +1 416 304 9629 : maria@xanadu.ai : Google Scholar Page

Prof. Fedor Jelezko, Ulm University *Ulm, Germany*

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